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विद्युताय संस्थापनों में सुरक्षा

भाग 9 उच्च बार्रबारता परा वैद्युत तापन संस्थापनों की विशेष अपेक्षाएं — विशिष्टि

Indian Standard

SAFETY IN ELECTROHEAT INSTALLATIONS

PART 9 PARTICULAR REQUIREMENTS FOR HIGH-FREQUENCY DIELECTRIC HEATING INSTALLATIONS

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Price Group 4

Industrial Electroheating Equipment Sectional Committee, ET 17

NATIONAL FOREWORD

This Indian Standard (Part 9) which is identical with IEC Pub 519-9 (1987) is one in the series of standards on Safety in electroheat installation covering safety requirements for high-frequency dielectric heating installations. This standard shall be read in conjunction with Part 1 of this standard covering general requirements. The text of the IEC Standard has been considered and adopted by ET 17 Industrial Electroheating Equipment Sectional Committee of BIS and approval of Electrotechnical Division Council.

CROSS REFERENCE

In this Indian Standard the following International Standards are referred to. Read in their respective place the following:

International Standard (IEC)	*Indian Standard*
IEC 519 - 1 Safety in Electroheat Installations Part 1 : General requirements	IS/IEC 519-1 (1984) Safety in electroheat installations : Part 1 General requirements

Indian Standard

SAFETY IN ELECTROHEAT INSTALLATIONS

PART 9 PARTICULAR REQUIREMENTS FOR HIGH-FREQUENCY DIELECTRIC HEATING INSTALLATIONS

1. Scope

This standard is applicable to industrial high-frequency heating installations for the purpose of thermal applications such as assembly by melting, melting and drying of partially or non-conductive materials such as plastics, wood, rubber, textiles, glass, ceramics, paper, foodstuffs, etc., in both normal and protective atmospheres, using for example inert gases or a vacuum.

This standard is to be read in conjunction with IEC Publication 519-1: Safety in Electroheat Installations, Part 1: General Requirements.

This standard relates to high-frequency dielectric heating installations, in the range 1 MHz to 300 MHz with output power greater than 50 W comprising high-frequency generators, and capacitors for the charge to be heated which, according to the requirements, may also contain the necessary mechanical devices.

Note. — In accordance with C.I.S.P.R. Publication 11: Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical (ISM) Radio-frequency Equipment (Excluding Surgical Diathermy Apparatus) there are preferred frequencies for industrial scientific and medical purposes. If other international or national regulations apply they shall also be met. C.I.S.P.R. Publications also give guidance regarding radio-interference suppression.

2. Definitions

For definitions of fundamental and general terms, refer to IEC Publication 50: International Electrotechnical Vocabulary (IEV), Chapter 841: Industrial Electroheating.

The following definitions apply for the purpose of this standard.

2.1 *High-frequency generator*

A high-frequency generator within the meaning of this standard is an electronic convertor having an operating frequency between 1 MHz and 300 MHz.

2.2 *Dielectric heating installation*

An equipment comprising the heating applicator, as well as the high-frequency generator, its supply and protective devices.

2.3 *Heating capacitor* (of a dielectric heater)

A capacitor formed by the work electrodes and the charge which is placed between them.

Note. — The shape of the work electrodes is adapted to the nature and form of the charge. There are not less than two electrodes. The voltage may be connected symmetrically or asymmetrically with respect to earth potential.

2.4 *Plate electrodes*

Work electrodes consisting of two or more plates, from which electrical energy is transmitted to heat the charge.

2.5 *Dispersed field electrodes*

Work electrodes usually in the form of rods, generally used for continuous heating.

2.6 *Dielectric applicator*

A device or equipment intended to handle the charge to be treated and which contains the work electrodes. Heating takes place in the HF field between and/or adjacent to the electrodes, the charge being at rest or in motion.

2.7 *Useful high-frequency power*

Active power absorbed by the substance to be heated.

2.8 *Nominal frequency*

The mid-point operating value of the frequency range.

2.9 *Frequency stability*

The ability of a high-frequency generator to maintain the specified frequency tolerances under all the variations of load which occur in normal operation.

2.10 *Mains supply voltage*

The voltage necessary for the operation of the high-frequency generator and auxiliary equipment.

2.11 *High-frequency electrode voltage*

The high-frequency voltage applied to the work electrodes.

2.12 *Electric field intensity* (HF working field)

The electric field intensity produced between and adjacent to the work electrodes. Its value is a function of the voltage applied to the electrodes, of the shape, of the geometrical dimensions of the latter and physical parameters of the charge to be heated.

2.13 *Input power*

The maximum input apparent power of the installation.

2.14 *Input rating of generator*

The apparent power absorbed by the high-frequency generator at the rated useful power.

2.15 *Rated useful output power*

The active power which can continuously be supplied by the high-frequency generator to the charge with the most favourable matching at mains supply voltage (see Sub-clause 2.10).

2.16 *Pulse power* (short-cycle power)

A high-frequency output power greater than the rated output power, its permissible value depending on the pulse duration and repetition rate.

2.17 *Power loss*

The active power absorbed by the installation from the supply which does not contribute to the heating of the charge.

2.18 *Calorimeter*

The calorimeter is an instrument for measuring the useful output power of the high-frequency installation, for example, comprising a capacitor through which the water flows at a measured rate and temperature rise.

3. High-frequency generator

3.1 *Description*

A high-frequency generator comprises:

3.1.1 The part which contains the components necessary for the supply and the distribution of power at mains frequency.

3.1.2 A rectifier part which generally contains the components for the conversion of mains frequency supply current into high voltage d.c.

3.1.3 An oscillator part which contains the components necessary for the generation and matching of high-frequency energy. The oscillator part is placed in a shielded enclosure to reduce high-frequency radiation.

3.1.4 The control and monitoring system which contains the programmed control with interlocks and safety devices for overload protection as well as switchgear and monitoring devices.

3.2 *Markings*

The following information shall be given on the identification plate:

- Name and address of manufacturer.
- Type and year of manufacture.
- Serial or batch number.
- Mains supply voltage.
- Mains frequency.
- Input power.
- Rated useful power in kilowatts (see Sub-clause 2.15).
- Nominal operating frequency.

Note. — The marking should comply with IEC Publication 519-1.

4. Protective measures

4.1 *Protection against direct contacts*

4.1.1 All live parts other than the output terminals of the high-frequency generator shall be located in one or more enclosures with adequate protection against direct contact.

4.1.2 It shall not be possible to open the doors or remove the covers giving access to these parts of the equipment with voltages above 50 V (bands 2 and 3) without the use of a special tool or key.

4.1.3 Hatches in the protective enclosures or movable parts of the protective enclosures shall have positively operated non-resettable safety switches or an interlock so arranged that the high-frequency voltage cannot be applied except when entry is insufficient to allow contact between the high-frequency parts and the hatch cover of the protective enclosure, or when the protective enclosure is effectively providing complete protection.

4.1.4 Necessary warning plates shall be provided.

4.2 *Other protective measures*

4.2.1 The equipment shall be protected by:

a) One or more devices to protect the apparatus against damage during conditions of abnormal service, such as overload,

b) If necessary, one or more devices for protecting the equipment from the disturbing influences of other equipment,

c) If necessary, one or more devices to protect the equipment from self-generated disturbances.

4.2.2 Devices shall be incorporated to protect against overtemperature, as necessary.

4.2.3 Adequate measures shall be taken to reduce induced voltages or currents to a safe level.

4.2.4 Care should be taken to avoid radio interference during normal operation of the electroheat installation. Guidance may be given in national or international regulations.

4.2.5 All sheathed cables, metallic conduits or pipes passing through those parts of the enclosure containing high-voltage circuits in the voltage bands 3 and 4 shall be earthed at the point where they pass through the enclosure.

4.2.6 Earthing of equipment employing d.c. and 50 Hz/60 Hz a.c. shall be in accordance with IEC Publication 519-1. The parts of the equipment carrying HF power are to be protected to ensure an admissible touch voltage at the operator's position, for example a protective earthed screen and/or earthing at the operator's position.

4.3 *Temperature rise—protection against fire*

4.3.1 In high-frequency generators circuits, and in reactifiers the electrical circuits shall be arranged so that they are not submitted to excessive temperature rises, nor should they produce a temperature rise in the enclosure in excess of the levels normally permitted for installations of electrical equipment.

4.3.2 Materials used in a compartment containing high-frequency voltages shall not be of a type which would allow any sustained burning.

4.3.3 In the case where a fault in the cooling circuit is liable to cause a temperature rise inside the generator in excess of the permitted value, monitoring devices shall be provided which either disconnect the installation or take other measures not to impair safety.

4.4 *Clearances and creepage distances*

The air clearances and creepage path employed for high-frequency and medium-frequency installations are not necessarily those used for mains frequency (50 Hz/60 Hz).

Where reduced values are employed (e.g. in high-frequency generators) measures shall be taken to prevent any flashovers from impairing safety.

4.5 *Internal electrical connections*

4.5.1 Conductors and connecting devices for carrying high-frequency current shall be made of non-ferromagnetic materials.

4.5.2 All low-frequency circuits shall be protected against the effect of high frequency by, for example fitting one or more high-frequency filters.

Note. — Low-frequency modulation of high-frequency supplies, for example as may be caused by using controlled rectifiers, can present a serious hazard and should be avoided where possible.

4.6 *Capacitors*

4.6.1 Where necessary, for safety reasons, all capacitor equipment of bands 2 and 3 shall be provided with a directly connected discharge device, unless it is connected directly to other electrical equipment providing a discharge path without having a disconnecting switch, fuse cut-out, or series capacitor interposed (see IEC Publication 110: Recommendation for Capacitors for Inductive Heat Generating Plants Operating at Frequencies between 40 Hz and 24 000 Hz).

Note. — A discharge device is not a substitute for short-circuiting the capacitor terminals together and to earth before handling.

4.6.2 When LC filters are used for the high-voltage supply to anodes, damping arrangements shall be provided if necessary to prevent inadmissible overvoltages from occurring when the circuit is disconnected.

4.7 *Cooling*

4.7.1 If components are water-cooled, appropriate measures shall be taken so as to limit electrolytic corrosion which would impair normal operation. Therefore, servicing instructions shall be strictly observed.

4.7.2 Water hoses and their arrangements shall be such that leakage currents are kept to a safe level.

Note. — As far as possible the formation of bubbles in cooling systems should be avoided.
Special attention may need to be given to hose fittings.

4.7.3 The condensation of water on water-cooled conductors carrying high-frequency currents shall be avoided.

4.7.4 For forced-draught, air cooled generators, precautions shall be taken to prevent any reduction in operating safety owing to the disposition of dust.

4.8 *Overload protection*

4.8.1 The circuits and components of generators, which in the event of an overload could reach temperatures higher than admissible temperatures, shall be provided with protection against the thermal overload.

4.8.2 Protection against overload due to short circuits which may occur in the high-frequency part, the d.c. part, or the mains part, shall be provided.

4.8.3 The high-frequency generator shall be provided if necessary with a sequential control equipment ensuring the protection of the personnel and the equipment when switching off under abnormal operating conditions.

4.8.4 In the case where the devices for treatment of the charge are located outside the generator, connections for remote control shall be provided, at least for operating the "emergency stop" device.

4.9 *Interference suppression*

4.9.1 The enclosures of parts containing high-frequency circuits shall be constructed in such a manner as to minimize high-frequency radiation passing outside. Doors and covers shall be provided with electrical shielding.

4.9.2 When in separate units, the high-frequency connections between the generator and applicator shall be screened.

4.9.3 Servicing, observation, and ventilation apertures of the high-frequency part of the generator shall be provided with adequate means of protection to minimize high-frequency radiation passing to the outside.

4.9.4 All power supply and control circuits to the high-frequency generator shall be provided with filtering devices, if necessary, so as to ensure that the interference suppression limits for the lines are not exceeded.

4.9.5 Metal conduits or covering forming screens, if exposed to high frequency, shall be connected with small inductance lead to the electrically conducting enclosure in order to ensure protection against interfering radiation.

5. **Protective measures for use in dielectric heating installations**

5.1 *Description*

Applicators include the heating capacitors with their fixing and positioning systems, and, where necessary, protective and screening devices, and means for transport and supply, ventilation, etc.

5.2 *Moving devices containing mechanical parts*

5.2.1 These devices shall be protected by a grill or similar protective means making it impossible to introduce a hand into the space in which such parts move. When the protective means are removed from their "safe" position, all movement of the mechanical parts shall cease. In the case of rigid protective means, it suffices that the removal of the device is impossible without the use of a special tool.

These provisions do not apply to manipulations carried out by the operator in normal service.

5.2.2 Instead of mechanical means, electronic or electrical devices may be used where appropriate; in the case of a fault in any protective device, all mechanical movement shall cease where danger to personnel might occur.

5.2.3 Care shall be taken to ensure that all parts in the handling area which exceed a temperature of 60 °C under operating conditions are protected from operator contact or are given a distinctive marking.

5.2.4 When all reasonable protection has been provided and certain potentially dangerous moving parts of an installation such as conveyor bands cannot be guarded for operational reasons, clearly marked warning notices should be provided.

5.2.5 Precautions shall be taken in the case of power operated presses to make it impossible for operating personnel to come into contact with dangerous moving parts during the working cycle, in order to comply with relevant national regulations.

5.3 *Processing charge of flammable substances*

When processing substances which are easily flammable, special precautions shall be taken.

5.4 *Protection against indirect contact*

Radiated high-frequency energy shall not induce, outside the screen or the enclosure, any voltages or currents which, in the event of contact with such external parts, are liable to present a hazard.

5.5 *Other protective measures*

5.5.1 Care shall be taken to render flashovers during normal operation unlikely.

5.5.2 Insulating supports shall be adequately designed with respect to their tensile and compressive strength, temperature and withstand voltage.

5.5.3 Mechanical parts inside the space subjected to the high-frequency field shall be protected in such a manner that the inevitably induced currents shall neither damage them nor impair their proper functioning.

5.5.4 For high-frequency processing treatment of liquid substances liable to spillage, the installation shall be provided with an overflow basin of suitable size.

5.5.5 Electrical conduits which are exposed to the high-frequency field shall be provided with adequate screening.

5.5.6 All metal parts inside the applicator shall be protected against static charges.

5.5.7 Metal parts of the equipment outside the normal screening shall where possible be adequately bonded to prevent excessive local temperature rises and/or excessive high-frequency interference.

5.5.8 Radiated high-frequency energy in the areas occupied by attending personnel shall comply with national regulations in the country in which the equipment is to be used.

Note. — In order to limit stray fields, reference is made to Sub-clauses 4.1.1 and 4.9.1. Values pertaining to this standard are under consideration.

6. Tests for protective measures

6.1 Test procedures shall be comprehensive and in all cases be such as to check all protective measures so as to ensure safety to operating personnel.

6.2 Where high-frequency circuits are accessible during normal use, their temperature shall not exceed 150 °C, this being checked by suitable means.

6.3 Short-circuit resistance: with the power control in the high-voltage generator set at maximum value, the accessible work electrodes or heating capacitor shall be short-circuited. There shall be no damage to the installation, or hazard for the operating personnel (such as flames, explosion or projection of matter, etc.).

6.4 The equipment is to be run for a period of time under conditions of full load in order that all components reach steady-state temperature conditions, except where impractical for equipments for short-cycle use. No part shall reach a dangerous temperature, that is, there shall be no temperature in excess of the permissible limits.

6.5 If free-standing, the apparatus shall have its centre of gravity low enough to ensure mechanical stability. Depending on the size of the equipment and by agreement between manufacturer and user, the stability may be verified by placing the apparatus on a plane inclined at 15° with the apparatus oriented in turn along each of the principal axes at 90° to each other. During this test the apparatus shall not fall over.

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